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REPORT
ON
NIMROD LAKE
PERRY AND YELL COUNTIES
ARKANSAS

EPA REGION VI

WORKING PAPER No. 490

WITH THE COOPERATION OF THE

ARKANSAS DEPARTMENT OF POLLUTION

CONTROL AND ECOLOGY

AND THE

ARKANSAS NATIONAL GUARD

JANUARY, 1977

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.
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REPORT ON NIMROD LAKE

PERRY AND YELL COUNTIES, ARKANSAS

EPA REGION VI

by

National Eutrophication Survey

Water and Land Monitoring Branch
Monitoring Applications Laboratory
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Eutrophication Survey Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 490

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U.S. ENVIRONMENTAL PROTECTION AGENCY

January 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Arkansas Department of Pollution Control and Ecology for professional involvement, to the Arkansas National Guard for conducting the tributary sampling phase of the Survey, and to those Arkansas wastewater treatment plant operators who provided effluent samples and flow data.

The staff of the Water Division of the Arkansas Department of Pollution Control and Ecology provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper series.

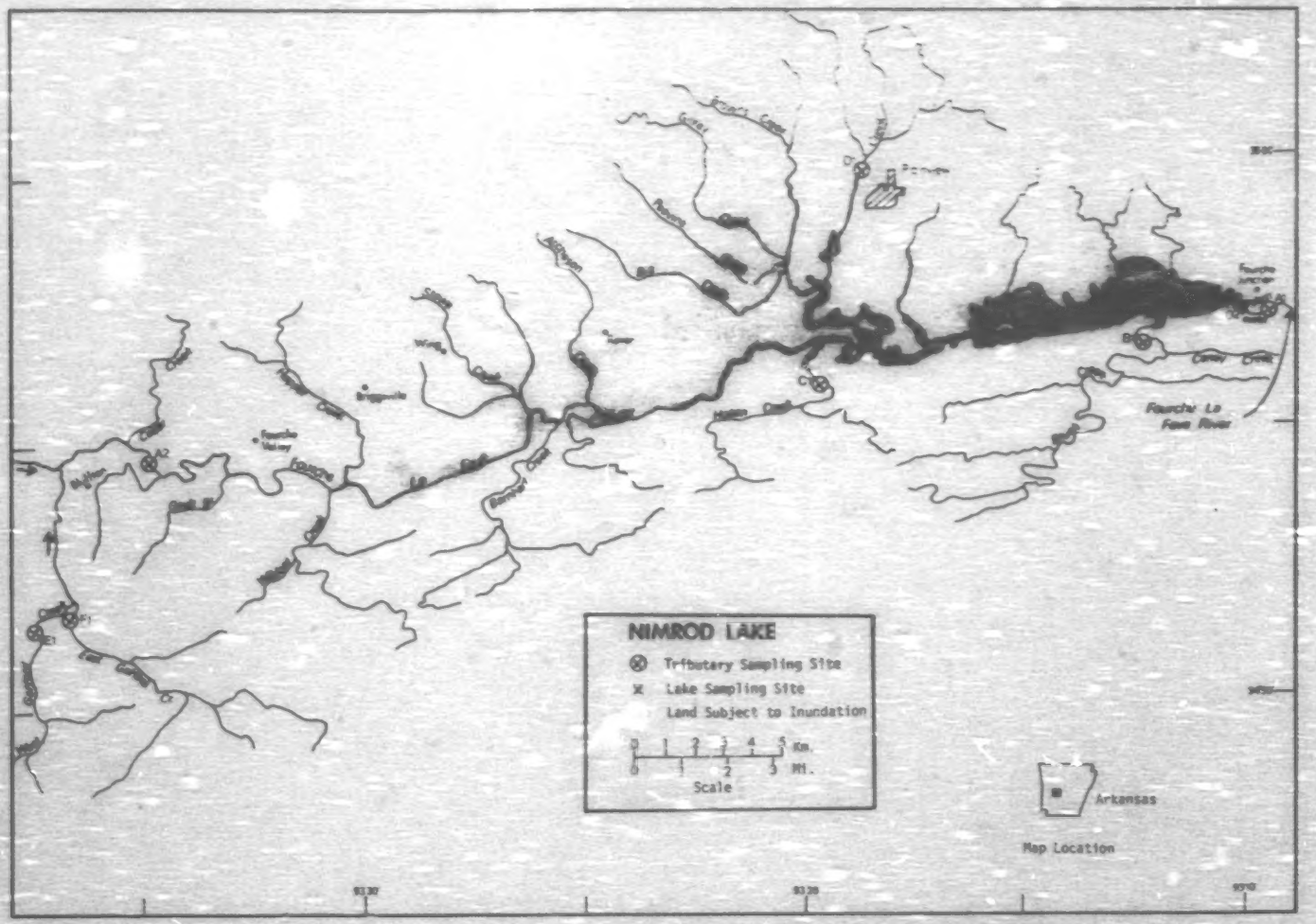
Major General Thomas C. Armstrong, the Adjutant General of Arkansas, and Project Officer Colonel Lavaun M. James, who directed the volunteer efforts of the Arkansas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF ARKANSAS

LAKE NAME	COUNTY
Beaver	Benton, Carroll, Washington
Blackfish	Crittenden, St. Francis
Blue Mountain	Logan, Yell
Bull Shoals	Baxter, Boone, Marion (Taney, Ozark in MO)
Catherine	Garland, Hot Spring
Chicot	Chicot
DeGray	Clark, Hot Spring
Erling	Lafayette
Grand	Chicot
Greer's Ferry	Van Buren, Cleburne
Hamilton	Garland
Millwood	Hempstead, Howard, Little River, Sevier
Nimrod	Perry, Yell
Norfork	Baxter, Fulton (Ozark in MO)
Ouachita	Garland, Montgomery
Table Rock	Boone, Carroll (Barry, Taney in MO)


NIMROD LAKE
Tributary Sampling Site
Lake Sampling Site
Land Subject to Inundation
0 1 2 3 4 5 Km.
0 1 2 3 MI.
Scale
Arkansas
Map Location
Fourche La Fave River
Petty Creek
Cedar Creek
Jones Creek
Pencil
Polecat
Jollyville
Lake
Mill
Cove
Creek
Fork
Ridge
Hollow
Branch
Bear
Big
Little
Rock
Spring
Mountain
Dry
Hickory
Oak
Pine
Walnut
Sugar
Maple
Cedar
Willow
Elm
Ash
Beech
Hickory
Poplar
Sycamore
Birch
Hemlock
Spruce
Fir
Pine
Oak
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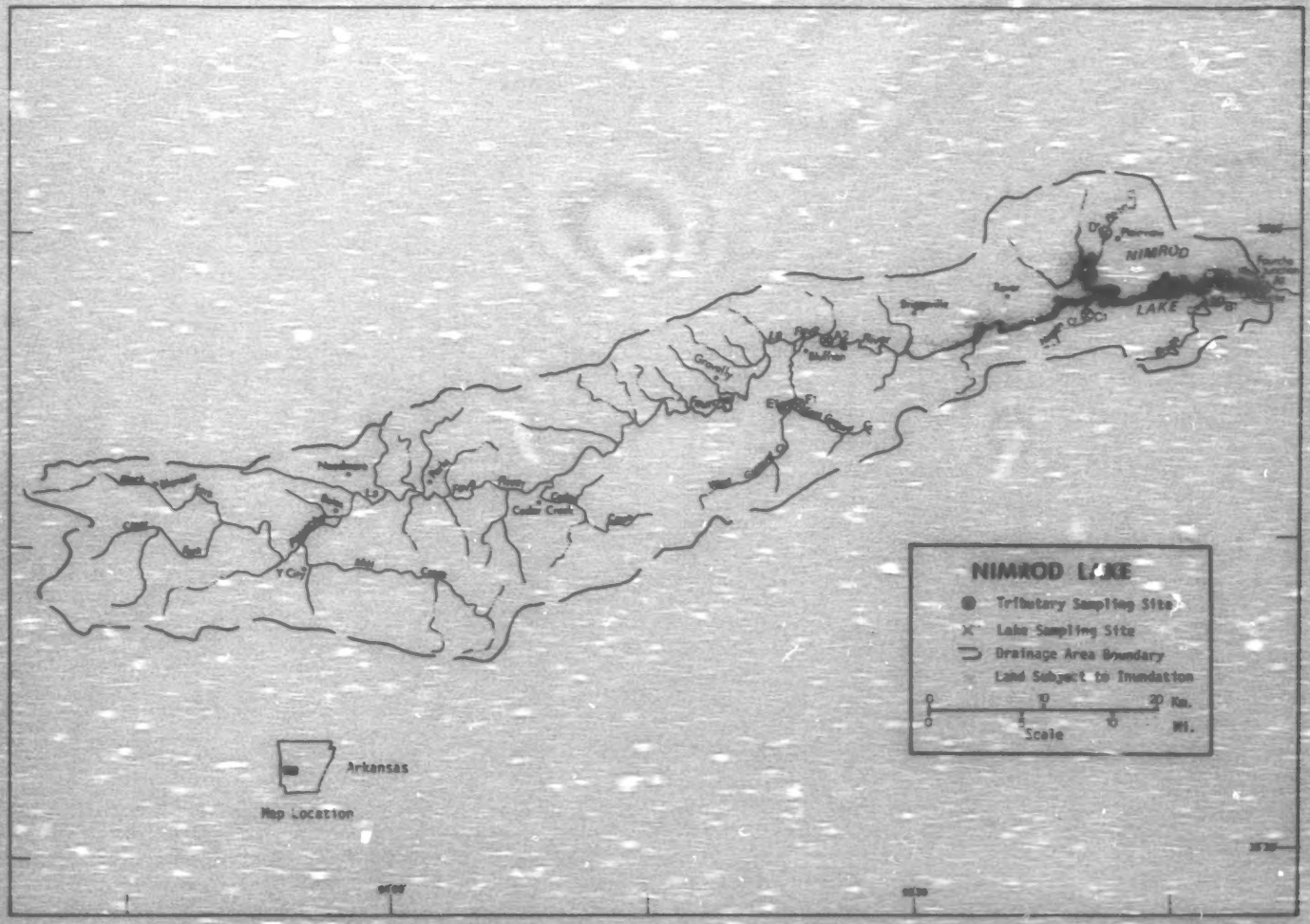
NIMROD
LAKE
NIMROD LAKE
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
Land Subject to Inundation
0 10 20 Km.
0 5 10 Mi.
Scale
Arkansas
Map Location

REPORT ON NIMROD LAKE, ARKANSAS

STORET NO. 0512

I. CONCLUSIONS

A. Trophic Condition:*

Survey data indicate that Nimrod Lake is meso-eutrophic. Potentials for primary production as measured by algal assay control yields were high. Chlorophyll a values ranged from 2.4 µg/l in the summer to 36.5 µg/l in the fall, with a mean of 15.8 µg/l. Of the 16 Arkansas lakes sampled in 1974, 6 had higher median total phosphorus levels (0.039 mg/l), 8 had higher median inorganic nitrogen values (0.160 mg/l), and 7 had higher median orthophosphorus levels (0.006 mg/l) levels than Nimrod Lake.

Field limnologists did not observe any algal blooms or nuisance aquatic weeds during their visits to the lake. Other studies (Arkansas Department of Pollution Control and Ecology, 1972) report that turbidity from colloidal clay particles is currently the major problem in Nimrod Lake, although in the late 1960's several extensive fishkills in Porter Creek and Nimrod Lake occurred as a result of discharges from the Mountain Pine Pressure Treating Company (Arkansas Department of Pollution Control and Ecology, 1975).

*See Appendix E.

B. Rate-Limiting Nutrient:

Algal assay results indicate that Nimrod Lake is limited by available phosphorus. Spikes with phosphorus, or nitrogen and phosphorus simultaneously resulted in increased assay yields. The addition of nitrogen alone did not elicit a growth response. The total available nitrogen to orthophosphorus (N/P) ratios in the lake data suggest nitrogen limitation in the spring and phosphorus limitation in the summer and fall.

C. Nutrient Controllability:

1. Point sources -

There were no known point sources impacting Nimrod Lake during the 1974 sampling year.

The phosphorus annual loading of 1.10 g $P/m^2/yr$ is less than that proposed by Vollenweider (1975) as a eutrophic level (see Section IV-F). However, loading calculations based upon available nutrients yield an extremely large net export of phosphorus from the impoundment. In view of this apparent phosphorus export, it is expected that the calculated loading rate is far too low, and that unmeasured phosphorus inputs, such as wastes from the town of Plainview into Porter Creek, reached the lake during the sampling year (Arkansas Department of Pollution Control and Ecology, 1972). Additional sampling to determine the true nutrient budget for the lake is needed before further recommendations on nutrient controllability in Nimrod Lake can be proposed.

2. Nonpoint sources -

During the sampling year, measured tributaries contributed 81.7% of the total phosphorus load to Nimrod Lake and ungaged drainage areas were estimated to have contributed 18.6%. The Fourche la Fave River contributed 78.7% of the total load.

The phosphorus exports of the three gaged tributaries (see Section IV-D) to Nimrod Lake were comparable to the tributary exports of nearby Blue Mountain Lake (range of 6 to 11 kg $P/km^2/yr$, mean of 8 kg $P/km^2/yr$) and Lake Ouachita (range of 6 to 11 kg $P/km^2/yr$, mean of 9 kg $P/km^2/yr$).

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake morphometry values were provided by the Arkansas Department of Pollution Control and Ecology. Tributary flow data were provided by the Arkansas District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by the mean flow of the outlet. Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 14.57 km^2.
2. Mean depth: 2.5 meters
3. Maximum depth: 12.3 meters.
4. Volume: 35.771 x 10^6 m^3.
5. Mean hydraulic retention time: 17 days.

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area (km^2)	Mean flow (m^3/sec)
A-2 Fourche la Fave River	1,271.7	17.59
B-1 Brush Creek	51.0	0.68
C-1 Hogan Creek	27.2	0.36
Minor tributaries and immediate drainage -	407.1	5.78
Totals	1,757.0	24.41
2. Outlet - A-1 Fourche la Fave River	1,771.6	24.04

C. Precipitation:

1. Year of sampling: 106.5 cm.
2. Mean annual: 90.7 cm.

III. LAKE WATER QUALITY SUMMARY

Nimrod Lake was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from one or more depths at each station (see maps, pages v-vi). During each visit, depth-integrated samples were collected from each station for chlorophyll *a* analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 2.7 meters at Station 01 and 10.7 meters at Station 02. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll *a* determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

...OOD LAKE
TOPET CODE 0512

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	(3/27/74) Sooo = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(6/ 1/74) Sooo = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(10/18/74) Sooo = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	4	10.6- 12.7	11.5	0.0- 1.5	4	23.6- 24.0	23.8	0.0- 1.5	3	18.3- 19.0	18.6	0.0- 1.5
MAX DEPTH**	2	10.3- 12.4	11.3	1.5- 7.6	2	23.2- 23.5	23.3	2.7- 10.7	2	18.3- 18.4	18.3	0.0- 9.8
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	2	9.2- 10.2	9.7	0.0- 1.5	2	6.4- 6.4	6.4	1.5- 1.5	3	6.1- 8.2	7.6	0.0- 1.5
MAX DEPTH**	1	9.2- 9.2	9.2	7.6- 7.6	1	6.6- 6.6	6.6	2.7- 2.7	2	6.2- 7.6	6.9	0.0- 9.8
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	3	70.- 95.	85.	0.0- 1.5	4	41.- 43.	42.	0.0- 1.5	3	23.- 23.	23.	0.0- 1.5
MAX DEPTH**	1	60.- 60.	60.	7.6- 7.6	2	42.- 43.	43.	2.7- 10.7	2	21.- 23.	22.	0.0- 9.8
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	3	6.2- 6.5	6.4	0.0- 1.5	4	6.5- 6.9	6.7	0.0- 1.5	3	5.8- 6.0	5.9	0.0- 1.5
MAX DEPTH**	1	6.2- 6.2	6.2	7.6- 7.6	2	6.6- 6.6	6.6	2.7- 10.7	2	5.8- 6.0	5.9	0.0- 9.8
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	3	10.- 13.	10.	0.0- 1.5	4	14.- 16.	15.	0.0- 1.5	3	10.- 12.	10.	0.0- 1.5
MAX DEPTH**	1	10.- 10.	10.	7.6- 7.6	2	14.- 15.	15.	2.7- 10.7	2	10.- 12.	11.	0.0- 9.8
TOTAL P (MG/L)												
0.-1.5 M DEPTH	3	0.032-0.037	0.034	0.0- 1.5	4	0.040-0.056	0.050	0.0- 1.5	3	0.033-0.041	0.039	0.0- 1.5
MAX DEPTH**	1	0.032-0.032	0.032	7.6- 7.6	2	0.048-0.052	0.050	2.7- 10.7	2	0.039-0.041	0.040	0.0- 9.8
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	3	0.023-0.027	0.025	0.0- 1.5	4	0.005-0.008	0.006	0.0- 1.5	3	0.005-0.010	0.005	0.0- 1.5
MAX DEPTH**	1	0.024-0.024	0.024	7.6- 7.6	2	0.006-0.010	0.008	2.7- 10.7	2	0.004-0.010	0.007	0.0- 9.8
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	3	0.080-0.100	0.090	0.0- 1.5	4	0.060-0.090	0.080	0.0- 1.5	3	0.030-0.300	0.030	0.0- 1.5
MAX DEPTH**	1	0.060-0.080	0.080	7.6- 7.6	2	0.040-0.090	0.065	2.7- 10.7	2	0.020-0.030	0.025	0.0- 9.8
AMMONIA (MG/L)												
0.-1.5 M DEPTH	3	0.060-0.070	0.070	0.0- 1.5	4	0.100-0.220	0.125	0.0- 1.5	3	0.060-0.060	0.060	0.0- 1.5
MAX DEPTH**	1	0.070-0.070	0.070	7.6- 7.6	2	0.110-0.120	0.115	2.7- 10.7	2	0.060-0.102	0.081	0.0- 9.8
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	3	0.300-0.400	0.400	0.0- 1.5	4	0.300-0.500	0.350	0.0- 1.5	3	0.400-0.400	0.400	0.0- 1.5
MAX DEPTH**	1	0.400-0.400	0.400	7.6- 7.6	2	0.400-0.400	0.400	2.7- 10.7	2	0.300-0.400	0.350	0.0- 9.8
SECCHI DISC (METERS)	2	0.6- 0.6	0.6		2	0.9- 0.9	0.9		2	0.7- 1.0	0.8	

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/27/74	1. Flagellates	1,933
	2. Ankistrodesmus	424
	3. Cryptomonas	424
	4. Centric diatoms	94
	5. Oscillatoria	94
	Other genera	237
	Total	3,206
06/07/74	1. Melosira	493
	2. Chroomonas	99
	3. Cryptomonas	49
	4. Cyclotella	49
	5. Dactylococcopsis	49
	Other genera	222
	Total	961
10/18/74	1. Melosira	1,417
	2. Microcystis	486
	3. Dactylococcopsis	445
	4. Cryptomonas	243
	5. Cyclotella	162
	Other genera	851
	Total	3,604

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
03/27/74	01	13.5
	02	3.2
06/07/74	01	3.5
	02	2.4
10/18/74	01	35.9
	02	36.5

c. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. 03/27/74

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
Control	0.020	0.188	2.3
0.05 P	0.070	0.188	6.3
0.05 P + 1.0 N	0.070	1.188	25.9
1.00 N	0.020	1.188	2.3

b. 10/18/74

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
Control	0.010	0.087	1.0
0.05 P	0.060	0.087	4.3
0.05 P + 1.0 N	0.060	1.087	12.1
1.00 N	0.010	1.087	0.8

2. Discussion -

The control yield of the assay alga, Scenedesmus capricornutum, indicates that potential for primary productivity was high in Nimrod Lake during the spring and fall sampling seasons. The lake was phosphorus limited at those times as indicated by the increased yield of the test alga in response to an addition of orthophosphorus. Spikes with phosphorus and nitrogen simultaneously resulted in a maximum yield. Spikes with nitrogen alone did not produce a response beyond the control yield.

The mean N/P ratio from lake data was 5/1 during the spring when orthophosphorus levels were approximately four times the summer and autumn values, suggesting nitrogen limitation. The N/P ratios for the summer and fall samplings were 29/1 and 19/1, respectively, indicating phosphorus limitation (an N/P ratio of 14/1 or greater generally reflects phosphorus limitation).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Arkansas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the maps (pages v-vi) except for the high runoff months of March and April when two samples were collected. Sampling was begun in June 1974, and was completed in May 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Arkansas District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual nutrient loads, in $kg/km^2/yr$, in Brush Creek and Hogan Creek at Station B-1 and C-1, and multiplying the means by the ZZ area in km^2.

A. Waste Sources:

1. Known municipal - None

2. Known industrial* -

Name	Product	Treatment	Mean Flow ($m^3/d \times 10^3$)	Receiving Water
Mountain Pine Pressure Treating Company	Wood Treatment and Preserving	----	----	----

(The plant presently operates with a closed treatment system for liquid wastes. In the past, the plant discharged into Porter Creek.)

*Arkansas Department of Pollution Control and Ecology, 1972.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Fourche la Fave River	12,580	78.7
B-1 Brush Creek	305	1.9
C-1 Hogan Creek	180	1.1
b. Minor tributaries and immediate drainage (nonpoint load) -	2,645	16.6
c. Known municipal STP's - None		
d. Septic tanks* -	15	0.1
e. Known industrial - None		
f. Direct precipitation** -	255	1.6
Totals	15,980	100.0

2. Output - A-1 Fourche la Fave River 30,565

3. Net annual P export*** - 14,585

*Estimate based on 18 lakeside residences and 6 camps.
**Estimated (see NES Working Paper No. 175).
***Export probably due to unknown sources and/or sampling error.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source		kg N/yr	% of total
a.	Tributaries (nonpoint load) -		
	A-2 Fourche la Fave River	417,285	77.0
	B-1 Brush Creek	9,900	1.8
	C-1 Hogan Creek	6,930	1.3
b.	Minor tributaries and immediate drainage (nonpoint load) -	91,395	16.9
c.	Known municipal STP's - None		
d.	Septic tanks* -	615	0.1
e.	Known industrial - None		
f.	Direct precipitation** -	15,730	2.9
	Totals	541,855	100.0
2.	Output - A-1 Fourche la Fave River	460,910	
3.	Net annual N accumulation -	80,945	

*Estimate based on 18 lakeside residences and 6 camps.
**Estimated (see NES Working Paper No. 175).

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Fourche la Fave River	10	328
Brush Creek	6	194
Hogan Creek	7	255

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P (mg/l)	Mean Total N (mg/l)
D-1 Porter Creek	0.040	0.684
E-1 West Gafford Creek	0.017	0.573
F-1 East Gafford Creek	0.025	0.419

Nutrient concentrations for tributaries D-1 and E-1 are in line with those found for the gaged tributaries draining into Nimrod Lake. However, mean total phosphorus values for Porter Creek are above those found for West and East Gafford Creek. This elevation in phosphorus levels is probably due to seepage and runoff from malfunctioning septic tanks from the town of Plainview (Arkansas Department of Pollution Control and Ecology, 1972).

F. Yearly Loadings:

In the following table, the existing phosphorus annual loading is compared to the relationship proposed by Vollenweider (1975). Essentially, his eutrophic loading is that at which the receiving waters would become eutrophic or remain eutrophic; his oligotrophic loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between eutrophic and oligotrophic.

Note that Vollenweider's model may not apply to lakes with short hydraulic retention times or in which light penetration is severely restricted by high concentrations of suspended solids in the surface waters.

	Total Yearly Phosphorus Loading ($g/m^2/yr$)
Estimated loading for Nimrod Lake	1.10
Vollenweider's eutrophic loading	1.35
Vollenweider's oligotrophic loading	0.67

V. LITERATURE REVIEWED

Arkansas Department of Pollution Control and Ecology, 1972. Pollution Control Survey of Arkansas River Basins, August - October, 1972. Little Rock, Arkansas.

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VI. APPENDICES

APPENDIX A

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

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APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR ARKANSAS 02/02/77

LAKE CODE 0512 NIMROD LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 1771.6

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
0512A1	1771.6	29.90	39.81	52.58	40.80	45.00	23.05	10.99	5.55	4.05	3.17	11.10	23.45	24.04
0512A2	1271.7	27.33	33.47	38.94	34.01	30.44	9.40	3.11	1.86	3.85	3.11	9.85	16.76	17.59
051281	51.0	1.359	1.300	1.512	1.320	1.181	0.365	0.122	0.074	0.150	0.122	0.382	0.651	0.683
0512C1	27.2	0.564	0.691	0.801	0.702	0.629	0.195	0.065	0.040	0.079	0.065	0.204	0.345	0.363
0512Z2	421.7	8.98	10.99	12.80	11.16	10.00	3.09	1.02	0.61	1.27	1.02	3.23	5.52	5.78

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 1771.6
SUM OF SUB-DRAINAGE AREAS = 1771.6
TOTAL FLOW IN = 294.43
TOTAL FLOW OUT = 289.45

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
0512A1	6	74	25.476	23	68.244				
	7	74	64.279	21	56.917				
	8	74	2.322	18	1.133				
	9	74	26.023	22	39.927				
	10	74	3.625	20	2.265				
	11	74	11.327	9	8.495				
	12	74	77.022	15	134.222				
	1	75	29.733	25	10.874				
	2	75	60.032	16	100.525				
	3	75	44.174	9	24.494	23	60.315		
	4	75	101.374	5	88.865	12	131.673		
	5	75	47.799	3	19.539				
0512A2	6	74	65.695	23	5.947				
	7	74	1.911	21	1.982				
	8	74	0.934	18	0.934				
	9	74	17.698	22	16.990				
	10	74	3.002	20	1.557				
	11	74	55.784	9	19.822				
	12	74	23.814	15	25.485				
	1	75	12.573	25	6.513				
	2	75	52.386	16	9.486				
	3	75	79.287	7	11.044	23	34.971		
	4	75	20.586	5	22.653	12	17.840		
	5	75	35.254	3	114.480				

TRIBUTARY FLOW INFORMATION FOR ARKANSAS 02/02/77

LAKE CODE 0512 NIMROD LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
0512B1	6	74	2.631	23	0.045				
	7	74	0.076	21	0.003				
	8	74	0.037	18	0.003				
	9	74	0.711	22	0.765				
	10	74	0.122	20	0.003				
	11	74	2.234	9	0.708				
	12	74	0.954	15	1.034				
	1	75	0.504	25	0.261				
	2	75	2.104	16	0.385				
	3	75	3.171	9	0.442	23	1.416		
	4	75	0.824	5	0.906	12	0.716		
	5	75	1.416	3	4.587				
0512C1	6	74	1.402	23	0.023				
	7	74	0.040	21	0.003				
	8	74	0.020	18	0.003				
	9	74	0.379	22	0.396				
	10	74	0.065	20	0.006				
	11	74	1.192	9	0.340				
	12	74	0.510	15	0.552				
	1	75	0.269	25	0.139				
	2	75	1.121	16	0.204				
	3	75	1.696	9	0.235	23	0.748		
	4	75	0.442	5	0.481	12	0.382		
	5	75	0.753	3	2.435				
0512Z2	6	74	21.747	23	1.971				
	7	74	0.634	21	0.623				
	8	74	0.309	18	0.309				
	9	74	5.862	22	5.635				
	10	74	0.997	20	0.510				
	11	74	18.463	9	6.513				
	12	74	7.900	15	8.495				
	1	75	4.163	25	2.152				
	2	75	17.387	16	3.171				
	3	75	26.306	9	3.653	23	11.610		
	4	75	6.824	5	7.504	12	5.918		
	5	75	11.695	3	37.945				

B4

APPENDIX C

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 77/02/02

051201
34 56 58.0 093 13 52.0 3
NIMROD LAKE
05149 ARKANSAS
101091

/TYPA/AMBNT/LAKE

11EPALES 04001002
0007 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/27	13 45	0000	12.7	10.2	24	95	6.50	13	0.060	0.400	0.080	0.027
	13 45	0005	12.4									
74/06/07	13 10	0000	23.6		36	41	6.50	14	0.120	0.400	0.080	0.007
	13 10	0005	23.6	6.4		41	6.70	15	0.220	0.300	0.090	0.006
	13 10	0009	23.5	6.6		43	6.60	15	0.110	0.400	0.090	0.010
74/10/18	09 55	0000	18.3	7.6	28	23	5.99	12	0.060	0.400	0.030	0.010

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32211 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/27	13 45	0000	0.037	13.5	
74/06/07	13 10	0000	0.056	3.5	
	13 10	0005	0.053		
	13 10	0009	0.052		
74/10/18	09 55	0000	0.041	35.9	
	09 55	0001			50.0
	09 55	0007			1.0

STORET RETRIEVAL DATE 77/02/02

051202
34 57 11.0 093 09 42.0 3
NIMROD LA[illegible]
05105 ARKANSAS

101091

/TYPA/AMBNT/LAKE

11EPALES 04001002
0033 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/27	14 00	0000	10.6		24	85	6.30	10	0.070	0.400	0.100	0.025
	14 00	0005	10.6	9.2		70	6.20	10K	0.070	0.300	0.090	0.023
	14 00	0025	10.3	9.2		60	6.20	10K	0.070	0.400	0.080	0.024
74/06/07	12 45	0000	24.0		36	42	6.70	14	0.130	0.500	0.080	0.008
	12 45	0005	24.0	6.4		42	6.90	16	0.100	0.300	0.060	0.005
	12 45	0015	24.0	6.4		42	6.50	14	0.110	0.300	0.040	0.005
	12 45	0035	23.2			42	6.60	14	0.120	0.400	0.040	0.006
74/10/18	09 25	0000	19.0	8.2	38	23	5.82	10K	0.060	0.400	0.300	0.005
	09 25	0005	18.8	6.8		23	5.81	10K	0.080	0.200	0.030	0.005
	09 25	0020	18.9	6.4		23	5.82	10K	0.100	0.300	0.020	0.004
	09 25	0032	18.4	6.2		21	5.81	10K	0.100	0.300	0.020	0.004

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/27	14 00	0000	0.034	3.2	
	14 00	0005	0.032		
	14 00	0025	0.032		
74/06/07	12 45	0000	0.040	2.4	
	12 45	0005	0.048		
	12 45	0015	0.034		
	12 45	0035	0.048		
74/10/18	09 25	0000	0.039	36.5	
	09 25	0001			50.0
	09 25	0005	0.033		
	09 25	0006			1.0
	09 25	0020	0.035		
	09 25	0032	0.039		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/11/28
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

0512A1
34 57 05.0 093 09 08.0
FOURCHE LA FAVE RIVER
35 7.5 NIMROD DAM
O/NIMROD LAKE
AR HWY 7 PROG 0.4 MI SE OF FOURCHE JCT
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/06/23	09 32		0.036	0.300	0.055	0.015	0.045
74/07/21	09 55		0.004	0.800	0.155	0.025	0.095
74/08/18	09 35		0.068	0.600	0.150	0.020	0.060
74/09/22	09 50		0.056	0.600	0.130	0.010	0.055
74/10/20	09 15		0.048	0.400	0.090	0.015	0.025
74/11/09	09 10		0.024	0.700	0.096	0.008	0.030
74/12/15	09 10		0.040	0.500	0.045	0.010	0.030
75/01/25	14 30		0.040	0.200	0.056	0.010	0.020
75/02/16	10 10		0.048	0.800	0.032	0.008	0.030
75/03/09	10 30		0.040	0.300	0.024	0.008	0.050
75/03/23	12 45		0.040	0.200	0.016	0.008	0.030
75/04/05	09 50		0.030	1.150	0.030	0.005	0.040
75/04/12	11 30		0.035	0.550	0.015	0.010	0.030
75/05/03	10 40		0.030	0.750	0.075	0.025	0.030

STORET RETRIEVAL DATE 75/11/28
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

051242
34 34 35.0 093 34 40.0
FOURCHE LA FAVE RIVER
05 YELL COUNTY
T/NI4R30 LAKE
AR HWY 28 BRDG 1 MI NE OF PLUMPTON
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/06/23	15	55	0.020	0.200	0.015	0.005K	0.025
74/07/21	11	00	0.012	0.300	0.020	0.010	0.037
74/08/18	10	40	0.024	0.300	0.015	0.005	0.025
74/09/22	10	55	0.064	0.300	0.045	0.015	0.040
74/10/20	09	28	0.016	0.100	0.025	0.010	0.010
74/11/09	10	30	0.048	0.700	0.136	0.016	0.020
74/12/15	10	00	0.056	0.300	0.015	0.010	0.020
75/01/25	15	00	0.040	0.100K	0.048	0.010	0.010
75/02/16	10	20	0.064	0.200	0.032	0.016	0.016
75/03/09	12	30	0.048	0.300	0.028	0.008K	0.050
75/03/23	15	10	0.092	0.200	0.024	0.012	0.030
75/04/05	12	30	0.060	1.400	0.020	0.005K	0.030
75/04/12	09	00	0.040	1.400	0.040	0.010	0.020
75/05/03	14	00	0.055	1.800	0.540	0.020	

— K VALUE KNOWN TO BE LESS THAN INDICATED —

STORET RETRIEVAL DATE 75/11/28
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

051231
34 56 34.0 093 12 00.0
BRUSH CREEK
05 7.5 NIMROD DAM
T/NIMROD LAKE
FOREST SERVICE RD KING 4.5 MI W AR HWY 7
LITTLE RIVER 2111204
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/06/23	09	00	0.024	0.100K	0.015	0.005K	0.010
74/07/21	10	10	0.020	0.200	0.020	0.010	0.030
74/08/18	09	50	0.016	0.200	0.015	0.020	0.020
74/09/22	10	15	0.040	0.300	0.025	0.010	0.015
74/10/20	09	35	0.040	0.300	0.015	0.007	0.007
74/11/09	09	25	0.016	0.600	0.128	0.008	0.020
74/12/15	09	35	0.032	0.400	0.020	0.005	0.010
75/01/25	14	45	0.024	0.100K	0.056	0.005	0.010K
75/02/16	10	30	0.032	0.100	0.016	0.008K	0.010K
75/03/09	09	20	0.032	0.100	0.012	0.008K	0.030
75/03/23	13	20	0.032	0.100K	0.024	0.008K	0.010K
75/04/05	10	30	0.030	1.250	0.025	0.005K	0.020
75/04/12	10	30	0.025	0.590	0.025	0.005K	0.010
75/05/03	11	00	0.020	1.850	0.040	0.010	

— K VALUE KNOWN TO BE LESS THAN — INDICATED

STORET RETRIEVAL DATE 75/11/29
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

351201
34 55 52.0 093 19 25.0
HOGAN CREEK
05 7.5 PLAINVIEW
T/NIMROD LAKE
BNK 12.5 MI WSW HWY 7 JCT
LIEPALES 2111204
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/06/23	10 21		0.012	0.100K	0.015	0.005	0.020
74/07/21	10 35		0.008	0.400	0.015	0.005	0.020
74/08/18	10 10		0.024	0.200	0.017	0.015	0.020
74/09/22	10 30		0.040	0.300	0.025	0.010	0.015
74/10/20	09 55		0.032	0.250	0.010	0.005	0.005
74/11/09	09 45		0.008	0.900	0.032	0.008	0.030
74/12/15	09 55		0.008	0.300	0.015	0.005	0.010
75/01/25	15 00		0.008	0.100K	0.048	0.005	0.010K
75/02/16	10 50		0.008	0.500	0.072	0.008K	0.010
75/03/09	09 10		0.008	0.200	0.012	0.008K	0.030
75/03/23	13 45		0.008	0.200	0.016	0.008K	0.010K
75/04/05	11 30		0.005	1.250	0.015	0.005	0.020
75/04/12	10 00		0.005	1.850	0.022		0.020
75/05/03	12 00		0.015	1.750	0.168	0.010	

D-13

— A VALUE KNOWN TO BE LESS THAN — INDICATED

STORET RETRIEVAL DATE 75/11/28
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

351201
34 59 53.0 093 18 34.0
PORTER CREEK
05 7.5 PLAINVIEW
T/NIMROD LAKE
2NDARY RD 8005 0.7 MI N OF PLAINVIEW
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00632 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/06/23	09	00	0.108	0.300	0.065	0.005	0.030
74/07/21	09	30	0.015	1.400	0.550	0.010	0.085
74/08/18	09	10	0.096	0.700	0.080	0.065	0.150
74/09/22	09	30	0.088	0.300	0.035	0.010	0.030
74/10/20	08	55	0.024	0.300	0.015	0.010	0.020
74/11/09	08	45	0.048	0.500	0.016	0.008	0.030
74/12/15	08	55	0.088	0.400	0.015	0.015	0.020
75/01/25	14	05	0.064	0.200	0.072	0.015	0.015
75/02/18	09	40	0.096	0.600	0.024	0.008	0.030
75/03/09	10	45	0.048	0.100	0.008	0.008K	0.040
75/03/23	12	20	0.084	0.100	0.022	0.012	0.020
75/04/05	09	00	0.080	2.000	0.025	0.010	0.030
75/04/12	13	30	0.040	0.550	0.010	0.010	0.020
75/05/03	10	10	0.050	1.200	0.080	0.035	

— A VALUE KNOWN TO BE LESS THAN INDICATED —

#-D

STORET RETRIEVAL DATE 75/11/28
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

3512E1
34 51 25.0 093 37 22.0
WEST BU-FORDS CREEK
05 15 GRAVELLY
T/AIMARD LAKE
NAT FOREST RD KING & MT SSW OF BLUFFTON
11EPALES 2111204
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 N02&N03 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/06/23	14	30	0.020	0.100K	0.015	0.005K	0.015
74/07/21	10	00	0.016	0.300	0.015	0.005	0.020
74/08/18	10	00	0.056	0.300	0.035	0.020	0.020
74/09/22	10	40	0.016	0.100	0.025	0.005K	0.010
74/10/20	09	10	0.032	0.100K	0.010	0.005K	0.010
74/11/09	09	30	0.008	1.500	0.032	0.008K	0.020
74/12/15	09	25	0.008	0.500	0.025	0.005	0.010
75/01/25	14	35	0.008	0.250	0.056	0.010	0.015
75/02/16	09	50	0.016	0.100	0.048	0.008K	0.030
75/03/09	13	20	0.008	0.300	0.016	0.008K	0.020
75/03/23	15	30	0.012	0.100	0.016	0.008K	0.010
75/04/05	13	15	0.005	1.200	0.020	0.005K	0.020
75/04/12	08	15	0.010	0.900	0.060	0.005K	0.010K
75/05/03	13	00	0.015	1.150	0.050	0.010	

K VALUE KNOWN TO BE LESS THAN
INDICATED

STORET RETRIEVAL DATE 75/11/28
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

0512F1
34 56 40.0 093 36 30.0
EAST [illegible]FORDS CREEK
05 13 GRAVELLY
T/NIMROD LAKE
NAT FOREST RD KING 3 MI S OF BLUFFTON
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/06/23	13	50	0.012	0.100K	0.015	0.005K	0.020
74/07/21	09	45	0.184	0.500	0.045	0.005	0.020
74/08/18	09	35	0.660	0.200	0.020	0.020	0.020
74/09/22	10	30	0.104	0.100	0.025	0.005	0.020
74/10/20	09	15	0.024	0.100	0.010	0.005K	0.010
74/11/09	09	35	0.008	0.150	0.024	0.016	0.020
74/12/15	09	35	0.008	0.200	0.020	0.010	0.020
75/01/25	14	40	0.008	0.100	0.048	0.005	0.020
75/02/16	10	00	0.008	0.300	0.032	0.008K	0.020
75/03/09	13	05	0.008	0.300	0.016	0.008K	0.050
75/03/23	15	25	0.012	0.100K	0.018	0.008K	0.020
75/04/05	13	00	0.005	1.000	0.020	0.005	0.030
75/04/12	07	50	0.010	0.400	0.015	0.010	0.020
75/05/03	13	25	0.020	0.625	0.210	0.015	0.055

K VALUE KNOWN TO BE LESS THAN INDICATED

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1974

STATE OF ARKANSAS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
0501	BEAVER LAKE	0.022	0.330	415.667	3.921	14.900	0.006
0502	BLACKFISH LAKE	0.424	1.470	496.125	19.775	12.000	0.040
0503	BLUE MOUNTAIN LAKE	0.058	0.160	484.000	8.983	14.600	0.010
0504	BULL SHOALS LAKE	0.015	0.380	343.969	3.995	15.000	0.004
0505	LAKE CATHERINE	0.029	0.180	451.667	14.042	11.800	0.006
0506	LAKE CHICOT	0.162	0.450	486.000	13.722	14.800	0.089
0507	DEGRAY RESERVOIR	0.019	0.130	419.050	12.300	15.000	0.004
0508	LAKE ERLING	0.054	0.120	454.667	13.389	14.600	0.020
0509	GRAND LAKE	0.101	0.090	479.667	62.867	8.400	0.021
0510	LAKE HAMILTON	0.024	0.130	428.111	10.889	14.400	0.004
0511	MILLWOOD LAKE	0.040	0.120	466.778	14.967	9.800	0.008
0512	NIMROD LAKE	0.039	0.160	469.000	15.833	8.800	0.006
0513	NORFOLK LAKE	0.015	0.320	356.321	3.441	15.000	0.005
0514	LAKE OUACHITA	0.015	0.155	389.144	4.344	15.000	0.006
0515	TABLE ROCK LAKE	0.022	0.350	410.778	9.103	15.000	0.007
0516	GREER'S LAKE	0.012	0.140	370.875	3.762	15.000	0.004

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLOrA	15-MIN OD	MEDIAN DISS ORTHO P
0501	BEAVER LAKE	63 (9)	27 (4)	67 (10)	87 (13)	40 (6)	63 (8)
0502	BLACKFISH LAKE	0 (0)	0 (0)	0 (0)	7 (1)	73 (11)	0 (0)
0503	BLUE MOUNTAIN LAKE	20 (3)	47 (7)	13 (2)	67 (10)	57 (8)	27 (4)
0504	BULL SHOALS LAKE	90 (13)	13 (2)	100 (15)	80 (12)	17 (0)	93 (13)
0505	LAKE CATHERINE	47 (7)	40 (6)	47 (7)	27 (4)	80 (12)	63 (8)
0506	LAKE CHICOT	7 (1)	7 (1)	7 (1)	33 (5)	47 (7)	7 (1)
0507	DEGRAY RESERVOIR	73 (11)	77 (11)	60 (9)	47 (7)	17 (0)	93 (13)
0508	LAKE ERLING	27 (4)	90 (13)	40 (6)	40 (6)	57 (8)	20 (3)
0509	GRAND LAKE	13 (2)	100 (15)	20 (3)	0 (0)	100 (15)	13 (2)
0510	LAKE HAMILTON	53 (8)	77 (11)	53 (8)	53 (8)	67 (10)	63 (8)
0511	MILLWOOD LAKE	33 (5)	90 (13)	33 (5)	20 (3)	87 (13)	33 (5)
0512	NIMROD LAKE	40 (6)	53 (8)	27 (4)	13 (2)	93 (14)	47 (7)
0513	NORFOLK LAKE	80 (12)	33 (5)	93 (14)	100 (15)	17 (0)	80 (12)
0514	LAKE OUACHITA	90 (13)	60 (9)	80 (12)	73 (11)	17 (0)	63 (8)
0515	TABLE ROCK LAKE	63 (9)	20 (3)	73 (11)	60 (9)	17 (0)	40 (6)
0516	GREER'S LAKE	100 (15)	67 (10)	87 (13)	93 (14)	17 (0)	93 (13)